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REPORT OF TWO CASES OF BULLET INJURIES TO THE LEFT LATERAL HALF OF THE UPPER PORTION OF THE SPINAL CORD.[1]

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(*Case I.—Spiculae of bone driven into left side of sixth or seventh cervical segment; operation, death on the seventh day. Case II.—Compression of the left side of cord opposite the first and second costal segments by a 22-caliber bullet lying external to the dura; operation, recovery.*)

Case I.—Thomas E. W., white, single, *aet.* 31, gambler by occupation, born in Ohio, lived in Colorado since 1885, was admitted into St. Luke's Hospital February 23, 1898.

Personal History.—He had most of the common diseases of childhood, but apparently made complete recoveries from them. When he was 12 years old he ran a harrow pin through his left heel. A scar is now visible just behind the internal malleolus. He had typhoid fever when 19 years old and was sick for six or eight months. He has been a hard drinker for a number of years. He took the Keeley cure in 1893, and stopped drinking for about a year. Since 1894 he has taken from twenty to thirty drinks of whiskey each day. He has used a great deal of tobacco, both smoking and chewing, for a number of years. He has been addicted to indiscriminate and excessive sexual indulgence. He does not think he has ever suffered from any venereal disease. His family history, so far as he knows, is good.

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[1] This paper was prepared for the meeting of the American Neurological Association, June, 1902, by the late Dr. Eskridge in association with Dr. Rogers.

On February 21, 1898, he was in a saloon at Victor, Colorado, had an altercation with a man who pulled a gun on him, held it near his chin and fired. Every muscle seemed to relax, he fell to the ground, did not lose consciousness, but was unable to rise and his friends carried him home.

After having been placed in bed he complained of a numb sensation in entire left side from shoulder downward, and found that he was unable to move the left arm or leg. He was able to move the limbs on the right side. A bullet wound was found in the front of his neck just to the left of the median line. There was no wound of exit for the bullet. The wound in the neck was dressed. He was taken to Denver late on the evening of the 22nd, and placed in St. Luke's Hospital. At 11.30 A.M., of February 23, or about forty hours after the wound had been inflicted, I saw him in consultation with Dr. Rogers.

Examination.—He is perfectly conscious and able to answer questions. He gives a detailed and connected account of the altercation, the shooting, his feelings immediately after the wound was inflicted and during the time that has intervened since the injury. His statements in regard to his subjective sensations, and his answers to my questions during a prolonged examination, lasting about one and a half hours, appear reliable and correct.

He is a large, muscular man, weighing about 200 pounds. His appearance shows the results of alcohol and other dissipation. He complains of shortness of breath, weakness, and pain in the right upper arm. The left leg and arm are completely paralyzed. He can move the right leg and arm. The left leg and arm feel numb, as if they were "asleep." This sensation is most marked in the hand. All the deep reflexes are normal in right leg, but absent in left. Plantar reflexes: R., present; L., absent. Cremaster reflex: R., present; L., absent. Abdominal reflexes absent. Deep reflexes of arms: R., present; L., nearly absent. Dyn. R., 62; L., 0. The face and tongue are unaffected. The neck muscles are not tested on account of the patient's weak condition and shortness of breath.

Tactile sense is lessened but not abolished on the left shoulder and over the left upper arm nearly to the elbow and to a very slight extent over the right hand and wrist. Throughout the trunk and other portions of the limbs, tactile sense appears to be unaffected.

Pain sensation is absent throughout right side from first intercostal space downward. It is absent also in the right arm from about the elbow downward in front and over the posterior surface of the entire arm. It is absent over the left shoulder and upper arm front and back downward nearly to the elbow. Over all other portions of the body pain sensation appears to be normal.

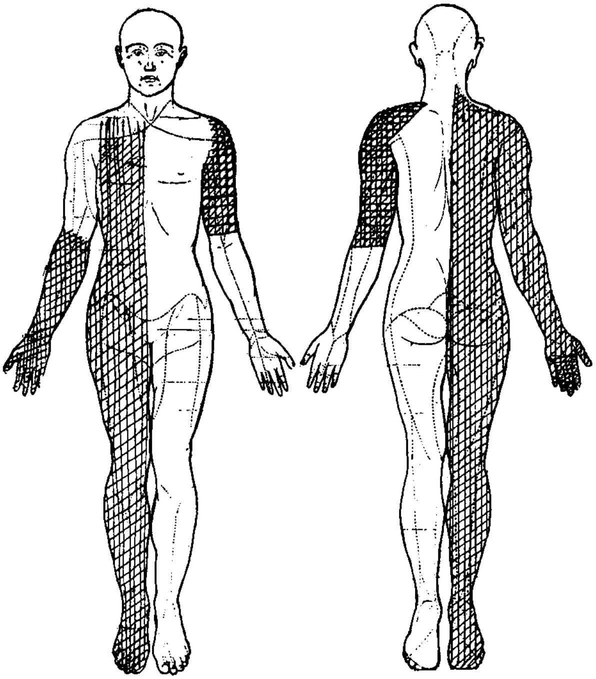
Temperature sensation throughout the areas in which pain sensation is lost, cold and warm substances are spoken of as warm. He is unable to distinguish between hot and cold or cool and warm substances in any portion of the analgesic areas. While the sensation of heat caused either by warm or cold substances cannot be said to be lost, yet the power to distinguish between substances of different temperatures is completely lost. Except in the areas above mentioned, temperature sensation does not vary from the normal.

Posture or muscular sensation seems normal in right leg and arm, but apparently lost in left leg and arm. Joint sensation seems perfect. Pressure sensation is imperfect in the tactile anesthetic areas, otherwise it is normal. Taste, smell and hearing seem normal. Vision, fields, disks, and fundi present no evidence of lesion. There is slight ptosis of the left upper eyelid. The right pupil is twice the size of the left; the latter is apparently normal in size. Both pupils respond to light, shade and accommodation, but the right is less active than the left. The patient was not aware that any difference in the size of the pupils had existed prior to the injury.

Diagnosis as to the Character, Extent and Location of the Cord Lesion.—It was of considerable importance to solve these problems, if possible, before attempting to operate. The wound had been carefully dressed by Dr. Rogers before I saw the man. I was informed that a 38-caliber bullet had penetrated the anterior portion of the neck nearly in the median line and apparently passed nearly directly backward. I did not see the wound until fifty-three hours later.

The results of the examination showed that only the left side of the cord had been injured and that the destruction of this side was not complete was evident from the fact that most of the fibers of tactile sense seemed to be intact. That the pyramidal fibers had been completely cut across was evidenced from the fact that all reflexes, both deep and superficial, were absolutely abolished on the left side of the trunk and in the left leg, and were scarcely perceptible in the left arm, forty hours after the injury had been received, although the corresponding reflexes on the right side, except the abdominal, were present and slightly increased. The fibers for muscular, pain and temperature sensations had also been cut across at the seat of the injury on the left side.

The questions were debated: Was the cord injury due directly to the bullet passing through the cord and membranes, or to a spicula of bone having been driven through the membranes into the cord by the force of the bullet? That a fatal hemorrhage had not occurred led me to believe that the bullet had not plowed its way through the membranes and cord. That the injury to the left side of the cord was not due to the presence of the bullet in the spinal canal and its pressure upon the cord seemed certain from the fact that the pyramidal tract had been completely cut across, as shown by the absence of the reflexes on the left side. It seemed to me most likely that the cord had been injured by some sharp cutting substance, probably a spicula of bone. If I were correct the probability was that the spicula of bone was partially or completely imbedded in the substance of the cord. Accordingly an operation was recommended.



Figs. 1 and 2—Horizontal lines indicate loss of tactile sense. Vertical lines indicate loss of pain sense. Oblique lines indicate loss of temperature sense.

The injury did not involve the whole of one lateral half of the cord, else the fibers of tactile sense would have been destroyed and we would have had tactile anesthesia on the right side. It must be remembered that tactile sense was not lost in any portion of the body or limbs, but was lessened in portions marked by horizontal lines in Figs. I and II.

As near as could be determined, the lesion was located in the sixth or seventh cervical segment of the cord.

The bullet had not been recovered, but where was it? Probably lodged among the spinous processes of one of the cervical vertebræ. If this were the case an operation for its removal at that time might endanger the man's life from hemorrhage, especially in his prostrated condition from shock, shortness of breath and refusal to take a sufficient quantity of food. On the other hand, if the injury to the cord were due to the presence of a spicula of bone in it, the sooner the offending substance was removed, the better.

The patient has to be catheterized. His temperature in each axilla is 99.2° F.; pulse 110; respirations 20 when he is quiet, but the latter increases considerably on the slightest exertion. He is restless, feels miserable and it is with great difficulty that we can get him to take sufficient liquid nourishment. The heart is free from murmur, the kidneys are acting well and the urine shows neither albumin nor sugar. The extreme restlessness and the poor quality of the pulse made it desirable to avoid a serious operation at the time, if possible. It was decided to nourish the man as much as possible and to stimulate him, to see if we could get him in a better condition for an operation.

February 24—He shows some apparent improvement; the temperature is normal, the pulse 80, quality a little better, respiration 20.

February 25—It is evident that the improvement is only temporary; the temperature begins to rise 99° F. at noon; the pulse and respiration, while not increased in frequency, are not as good as they were the day before. The patient is becoming apathetic. The serious nature of his condition is explained to him. He is told that an operation may do good, but that the chances are against him. He decides that his physicians are the best judges and leaves the matter of operating to them.

OPERATION AND REMARKS.

BY DR. ROGERS.

Operation at 4.15 P.M., on February 25. A 38-caliber bullet is extracted from beneath the skin on the posterior portion of the neck, about one inch to the left of the median line. It is found by passing the finger in the track made by the bullet posterior to the spinal column that the sinus leads from the transverse process of what is apparently the fifth cervical vertebra. The conical end of the bullet is found to be flattened, its sides scarred, a piece of the metal clipped off, and left as was supposed in contact with the bone. On enlarging the sinus made by the bullet in its track through the bones of the spinal column, it is ascertained that the bullet emerged from the bone through the fossa between the fourth and fifth cervical transverse processes. The lamina of the fifth cervical vertebra is quite loose on the left side and broken into many pieces. The bullet had entered the spinal canal through the body of the fifth cervical vertebra. A piece of bone ⅜ of an inch in diameter is found within the spinal canal and lying external to the membranes. Two smaller pieces of bone, one round, 3-16 of an inch in diameter, the other a thin spicula, about ⅛ of an inch in diameter, had been driven through the membranes and into the lateral substance of the cord. These pieces of bone are removed. The bleeding is quite free. The bullet had not torn the membranes and so far as we were able to determine, it had not directly injured the cord. The cord was apparently damaged solely by the small pieces of bone that had been driven into its substance. There is not much bleeding within the membranes.

The patient is returned to the surgical ward at 5.30 P.M. During the night his temperature did not fall below 98° F., nor rise above 98.2° F. The pulse immediately after the operation was 110, rose to 116 by 7.30 P.M., but was 96 at 5 the next morning. Respirations continued about the same as before the operation, 24 per minute. It was evident that the operation caused no perceptible shock or apparent depression.

By 10 A.M., of the 26th, T. 101.4° F.; P. 108; R. 30. From this time on the decline was progressive and comparatively rapid. At 12 M., T. 102° F.; P. 132; R. 32. At 6 P.M., T. 102.2° F.; P. 140; R. 39. During the night the pulse ranged from 140 to 150, respirations from 36 to 40 and the temperature at 6 A.M. of the 27th was 103.6° F. At this time he had become comatose. He died at 12.30 P.M. on the 28th. His temperature did not go above 103.4° F.

Autopsy on the body of Mr. Thomas E. W. was made at 4.30 P.M. of February 28, 1898, four hours after death. The body is still warm; post-mortem rigidity is just beginning in jaw, chest and limb muscles. Only the parts at the site of the injury and surgical operation were examined. No pus and very little blood was found. The cervical portion of the cord was greatly softened. This softening, inflammatory in character, had begun to involve the medulla. On sectioning the cord into blocks the edges at the end of each section everted, especially was this well marked opposite the seat of injury to the cord. The substance of the cord at this point seemed to have undergone softening throughout its entire transverse extent.

The wound of the cord inflicted by the spiculæ of bone was in the left lateral aspect of the cord and did not appear to penetrate more than one-half the distance from the surface to the central canal of the cord. The wound involved directly only the extreme outer portion of the gray matter. The wound was wedge-shaped, with its base at the surface of the cord. The spiculæ of bone had not penetrated the anterior and posterior portions of the left lateral half of the cord, neither had the central gray matter of this half of the cord been reached by the spiculæ.

The cervical and upper costal portions of the cord and the medulla were placed in Müller's fluid and allowed to harden slowly for three months. The fluid was poured off and renewed every few days during the first two weeks. Before the cord was subjected to microscopic examination it was placed in a 2 per cent. solution of formaldehyde for a few days.

The microscopical examination was made by the late Dr. E. R. Axtell. Over 100 sections from the medulla, cervical and costal portions of the cord were carefully cut and examined. The sections showed softening throughout the cervical region of the cord. The softening was slight in the right lateral half of the cord, but in the left, especially in the region of the injury inflicted by the bone, it was very well marked and attended by hemorrhagic extravasation. The microscopic sections developed the fact that the spiculæ of bone had not penetrated the left lateral half of the cord to more than one-third the distance to the central gray matter immediately surrounding the central canal of the cord. The anterior and posterior portions of the left half of the cord had not been injured by the bone. The left side of the cord immediately in the vicinity of the lesion in the cord made by the pieces of bone, showed a degree of softening further advanced than the parts more remote from the site of the injury.

Case II.—Wm. R. D., *aet.* nineteen years, white, male, born in Texas, by occupation laborer in a cotton mill, was admitted into the surgical ward of the Arapahoe County Hospital, March 6, 1898, about 7 P.M. The family history was negative. The boy was tall (height 6 ft. 2 in.), lean and lanky. He was not otherwise well developed. His personal history was uninteresting.

On March 6, 1898, he was accidentally shot by a companion who stood some fifteen or twenty yards behind him. A 22-caliber, short conical bullet, coming from a Colt rifle, struck him in the left posterior portion of the neck. He immediately fell to the ground, but consciousness was undisturbed, and he was able to describe subsequently all the sensations that he experienced at the time. His companions found that he was paralyzed in the left leg and to a partial extent in the left arm. Immediately after the receipt of the injury the boy experienced a numb sensation in the right leg and arm, and great pain in both arms and legs. The pain was more severe in the limbs on the left side than in those on the right.

I saw the patient at 9 P.M., five hours after the accident, in consultation with Drs. Rogers and Howell T. Pershing, the former one of the surgeons and the latter the neurologist, to the hospital. I wish in this connection to acknowledge my indebtedness and express my thanks to Drs. Pershing and Rogers for the privilege of studying the case over a prolonged period and for permission to use my notes of it in connection with Case I, just reported in this paper.

The first neurological examination was made conjointly by Dr. Pershing and myself. All the muscles of the left leg are very weak, yet by an effort of the will almost all movements can be effected, although very feebly. Complete paralysis of the left wrist and fingers exists. He cannot extend the left arm at the elbow, but can feebly flex it at this joint. None of the shoulder movements are entirely lost, but are all very weak. All muscles of the right leg, arm, sides of the neck, face and tongue are normal in strength. Dyn. R. 130; L. 0. There is no ptosis of the upper eyelids and the pupils are equal in size and respond readily to light, shade and accommodation. Deep reflexes of legs and arms are slightly increased on right side and decidedly increased on the left. Plantar and cremaster reflexes: R. normal; L. greatly diminished. Abdominal: R. present; L. absent.

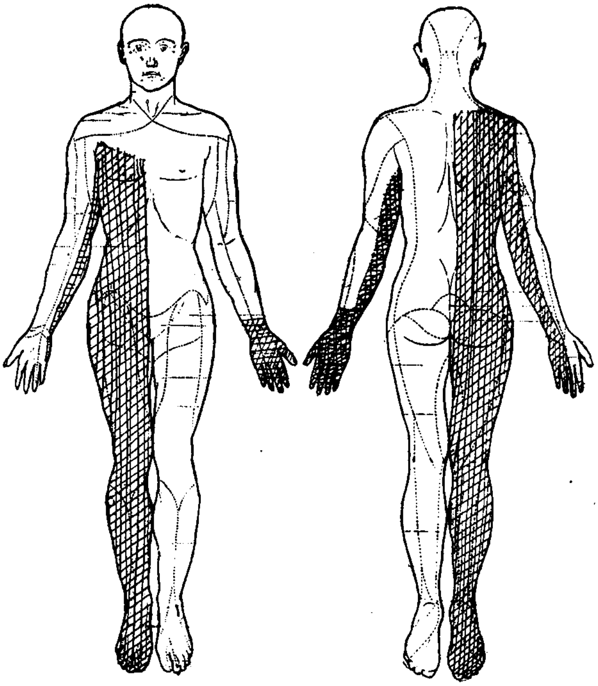
Sensory phenomena: Tactile sense is partially lost on the entire left hand, on the anterior surface of forearm for a distance of two inches above the wrist joint, on the posterior surface of forearm to a point three inches above the wrist joint, and on the posterior and extreme inner surface of the forearm and arm nearly to the axilla. (See Fig. IV.) Over all other portions of the body and limbs tactile sense is normal.

Pain sensation is lost in the entire right leg, on the right side of the trunk anteriorly to the third intercostal space and posteriorly to the seventh cervical spine; in the right arm and hand anteriorly there is only a slight disturbance on the extreme inner margin, posteriorly on the hand and arm to the shoulder on the inner one-half of the surface; over left hand and arm anteriorly, there is apparently no disturbance to pain sensation, but posteriorly marked loss in the tactile anesthetic area.

Temperature sensation is perverted or lost in the areas in which pain sensation is affected. (See Figs. III and IV.)

Muscular sense is absent in left leg and hand. Pressure sense absent in area of tactile anesthesia. Joint sense is absent in left fingers and wrist.

Ten days after Dr. Rogers and I had studied Case I, we encountered Case II, almost a counterpart, so far as neurological symptoms were concerned, of Case I, except that in Case II, the lesion was a little lower in the vertical level of the cord, and the deep reflexes were preserved on the left side and slightly increased. It will be remembered that loss of pain and temperature sensations began opposite the first intercostal space in Case I, and opposite the third intercostal space in Case II. In Case I all the reflexes, deep and superficial, were abolished on the left side from the level of the lesion in the cord downward, just the opposite of what we have just stated occurred in Case II.



Figs. 3 and 4—Horizontal lines indicate tactile anesthesia. Vertical lines indicate analgesia. Oblique lines indicate loss of temperature sensation.

Having so recently met with Case I, studied the clinical phenomena and examined the lesion in the cord at the post-mortem examination, I felt justified in making a diagnosis of pressure on the left lateral half of the cord opposite the second or third costal segment. In the light of my recent experience with Case I, Dr. Pershing readily agreed with me in the main features of the neurological diagnosis. It seemed to both of us a most favorable case for immediate surgical interference, and the patient agreeing, Dr. Rogers at once proceeded to operate.

OPERATION AND REMARKS.

BY DR. ROGERS.

The wound in the skin, indicating the point at which the bullet had entered the neck, was small and situated a little to the left of the median line and at a point nearly opposite or a little below the spinous process of the seventh cervical spine. On following the track of the bullet from its point of entrance posteriorly, the bullet and a small spicula of bone are found within the spinal canal, external to the membranes, but in such a position as to allow them to exert pressure on the left lateral half of the cord at a point opposite its upper costal region, or it may be opposite the junction of the cervical and costal regions. It is impossible to determine upon which segments of the cord the bullet presses. The spinal membranes had not been injured by the bullet or spicula of bone. There is very little hemorrhage in the spinal canal. Only a small quantity of blood is lost during the operation.

The wound healed satisfactorily and surgical recovery was rapid and uninterrupted, the temperature at no time rising more than one or two degrees above normal. The pulse and respiration were only slightly affected.

SUBSEQUENT NOTES BY DR. ESKRIDGE.

On March 12, six days after the receipt of the injury and the surgical operation, the sensory phenomena remained about the same as they had been before the operation, but the boy seemed greatly depressed. The temperature and respiration are nearly normal, but the pulse is weak and 100 per minute. The appetite is poor, the patient restless. It is difficult to get him to make any muscular movements. Both knee-jerks are absent. The other deep reflexes are lessened and all the superficial reflexes are absent. The right pupil is nearly twice as large as the left.

March 16, 1898. Right leg is strong in all movements. Left foot in almost complete plantar flexion, but he is able by voluntary effort to increase the plantar flexion of left foot. Dorsal flexion of the left foot completely lost. There is slight power of movement at left hip and knee. Dyn. R. 30; L. 0. Right elbow and shoulder movements about one-half normal strength. Unable to flex fingers of left hand, can extend left hand at wrist. He can flex left arm at elbow, but cannot extend it. Shoulder movements lost. Intercostal muscles of left side paralyzed. The major pectoral muscle on each side acts well.

Knee-jerks, R. normal; L. lessened. Plantar; R. slight, L. absent. Tendo Achillis, R. slight; L. absent. Cremaster and abdominal reflexes present. Deep reflexes of arms increased, the left to a greater degree than the right. The strength of the muscles about neck and shoulder, for the most part, cannot be tested on account of the presence of the dressings.

Sensory phenomena. Tactile sense throughout the entire right side to a camel-hair pencil held in contact with the parts is present, and also throughout left side, except over a small area on lower posterior inner one-half of upper arm, one inch in width and four inches long; over another area on forearm extending from elbow to wrist joint, one inch in width and lying on the extreme posterior ulnar of arm; also over entire left hand, palmar and dorsal surfaces and for about three inches above the wrist both anteriorly and posteriorly.

Temperature and pain sensations absent on right side from the third intercostal space downward, also over areas of tactile anesthesia and dulled over portions of right forearm. Posture sense absent in left arm and leg. Joint sense absent in left wrist and finger joints; present throughout right side. Examination of the organs of special sense reveals nothing abnormal except that the right pupil remains about twice as large as the left. Both responsive, left more readily than the right.

March 19. *Slight improvement.*

March 24. All movements of left leg, including foot and ankle have returned, but they are weak. No improvement in left arm movements, except that he can rotate the left forearm slightly. A few days later he could flex and extend hand at wrist. All forms of sensation remain about the same.

April 8. Tactile sense is restored on left wrist and hand down to the metacarpo-phalangeal joints, except on radial side of hand over which loss of tactile sense still remains sufficient to be detected by a camel-hair pencil in motion. Thermo-anesthesia is lessening on right arm and foot, that on the leg and body remain nearly the same as at first. Loss of pain sensation is not lessened but has extended a little on posterior surface of right arm. Ankle-clonus is recognized on the right side for the first time today. Deep reflexes exaggerated. Muscular sense still absent in left arm and leg.

He gradually improved, and by May 1, was able to walk with the assistance of a cane. When he first began to try to walk it was extremely difficult for him to do so on account of the loss of muscular sense in the left leg. He had almost completely recovered by July 1, except that muscular sense in the left leg and arm is still defective. He left the hospital early in August. At that time he was feeling quite well, muscular sense was lessened in left arm and very decidedly defective in left leg, requiring him to use his eyes in walking. He had not entirely recovered his normal power of motion in the left leg and arm. Pain and temperature sensations were less acute on the right side than on the left. Tactile sense seemed perfect everywhere. I saw him one or two months later and his recovery was apparently complete, with the single exception that muscular sense was still defective in left leg, but much less than when he left the hospital. In the fall of 1898 he went to Nebraska and resumed his work in a cotton mill. I have not been able to obtain any word from him since he left Colorado, although I have written two or three times.

It is almost enough to make one weep to be apparently so near the solution of interesting problems, determining the function of the direct cerebellar tracts and the position in the cord of the fibers for pain, temperature and muscular sensations, and utterly to fail.

The spiculæ of bone had apparently completely cut across the left direct cerebellar and the crossed pyramidal tracts and the posterior portions of the antero-lateral ascending tract and the anterior ground fibers. Had the lesion extended no further than that directly inflicted by the spiculæ of bone, and had the patient survived a few weeks after the injury, a careful study of Case I would in all probability have resulted in brilliant results. The early death of the patient, the extensive inflammatory softening and the hemorrhagic infiltration blasted my hopes. My experience seems, in this direction, to be but a repetion of that of all neurologists who have had an opportunity to study similar cases. Sir William R. Gowers in 1878 recorded a case in many respects, so far as the lesion is concerned, almost a complement to Case I, detailed in this paper. In this hemorrhage and hemorrhagic extravasation took place[2].

There are, however, several points of interest suggested by the report of the two cases included in this paper, and seem to me worthy of discussion by the members of this Association. The ciliospinal center was affected in both cases. In each, it will be remembered, the injury was to the left side of the cord. In Case I, I quote from notes, made at the bedside of the pa-

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[2] "Diseases of the Nervous System," Vol. I. Third Edition, 1899, p. 235. Blakiston Son & Co., Philadelphia.

tient, "There is slight ptosis of the left upper eyelid. The right pupil is twice the size of the left; the latter is apparently normal in size. Both pupils respond to light, shade and accommodation, but the right is less active than the left. The patient is not aware that any difference in the size of the pupils existed prior to the injury." It may be well for me to remind you in this connection that the injury to the cord in Case I was to the sixth and seventh cervical segments. In Case II, the bullet lay in the spinal canal, external to the dura, in such a position as to exert pressure on the second and third costal segments. In this case there was neither ptosis of the upper eyelid nor affection of either pupil a few hours after the receipt of the injury; and dilatation of the right pupil was not observed until six days after the receipt of the injury, although the boy was visited by me daily and observed closely. By this time edema of the cord had probably taken place and involved the first costal segment. On March 16, the right pupil remained about twice the size of the left. On March 19, both pupils were equal and remained so until the patient passed from under my observation, several months later.

I was unable to satisfy myself that the palpebral fissures varied from the normal either in Case I or II.

The results obtained by a careful study of the two cases reported in this paper suggest that there may be fibers in the cervical region of the spinal cord that aid in elevating the upper lid of the eye of the same side, and in modifying the size of the pupil of the opposite side. I know that these results are directly opposite to what has been found by experimentation, but are not the conditions different? In experimentation the nerve roots have been irritated or sectioned. In most cases of disease of the cervical or extreme upper costal regions of the spinal cord attended by pupillary changes the nerve roots have been affected, besides there have been, in most instances, vasomotor disturbances. In neither case reported in this paper were there any vasomotor changes on either side. In Case II, the irritation apparently never extended to the nerve roots. In Case I there was no evidence that it had at the time of the examination, such as would have been shown by vasomotor disturbance.

Irritation of the nerve roots of the cervico-brachial plexus, certainly of the lower portion will give rise to dilatation of the pupil and widening of the palpebral fissure of the same side. Seguin observed myosis after section of these roots.

At first I thought my observations were at fault. I went over them repeatedly and the results were always the same. In Case I, the left pupil was normal in size and responded readily to light, shade and accommodation. The right was twice the size of the left and reacted slowly and imperfectly to all tests. In Case II, the pupils at first were equal and normal in size and both reacted perfectly. Six days later the right pupil was twice the size of the left and like the right pupil in Case I, reacted tardily and imperfectly. This condition continued for a period of seven days. At the expiration of this time the right pupil was as small as the left had been from the first and responded readily and perfectly to all tests. After all, we should expect the fibers for the ciliospinal center to cross in the medulla, but so far I have been unable to find any recorded cases that seem to confirm this. Kocher believes that the ciliospinal center extends from the medulla to the first costal segment.

One of the most curious conditions in Case I, was the ptosis of the upper eyelid on the side of injury to the cord. The patient said he had, so far as he was aware, no venereal disease and he was not a man likely to deny syphilitic infection had he suffered from it. I was unable to find any other symptom pointing to syphilis. His physician had never observed anything wrong with the man's eyes prior to the injury from the bullet.

It is interesting to note in connection with Case I, that all reflexes were abolished from the level of the cord injury downward on the side of the lesion, and on the side of the body on which the only form of sensation abolished or disturbed was muscular sensation. This not only supports Bastian's theory that a complete severance of the cord in any portion abolishes all reflexes below the point of lesion, but that so far as the cord is concerned the presence of the reflexes is dependent upon the motor and muscular sensation fibers and their associated neurones, axons and dendrons.

That some of the fibers of muscular sensation run in the posterior median columns seems certain from a study of the symptoms and pathology of tabes. In Case I, these columns were not affected by the lesion, yet loss of muscular sensation was complete on the side of the injury. The inference naturally is, that all the fibers of muscular sensation do not run in the posterior median columns. In this connection a quotation from Gowers is interesting. "The function of the direct cerebellar tract has still to be demonstrated. There are certain resemblances between its fiber-relations and those of the posterior median columns which gives countenance to Flechsig's theory that it conveys impressions from the muscles of the lower part of the trunk and between the trunk and the lower limbs. But the origin of its fibers from the cells of the posterior vesicular column, and the mystery attaching to the latter, give additional obscurity to this structure. The fine nerve-plexus between the cells seems connected with the fibers of the posterior roots, and this plexus is said to atrophy early in locomotor ataxy. The obscurity will, indeed, be dispelled if we can accept the speculation of Sherrington that this cylinder is really part of the series of ganglia on the posterior nerve-roots, which occupies a position within the spinal cord, and is continuous instead of broken into ganglia[3]."

Unfortunately a study of Cases I and II gives us no clue to the exact positions in the cord occupied by the fibers for pain and temperature sensations and tactile sense further than to emphasize the fact already known that the fibers for pain and temperature sensations lie near together in the cord and are not immediately joined by the fibers for tactile sense.

Pressure sensation is closely related to tactile sense and is probably a part of it. In the cases reported in this paper pressure sensation was only involved in the areas in which tactile sense was affected. The power of localization seemed to be preserved except in these areas.

What is joint sensation? With what form of sensation is it associated? Is it a part of tactile sense? In the above cases it was preserved, as nearly as I could determine, except in the joints over which the skin was completely or partially anesthetic.

The interesting character of the cases that I have just reported and the care with which I have tried to study them, constitute my only excuse for the length of my paper.

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[3] *loc. cit.*, p. 237.